ADVANCED LIFE SCIENCE: FOODS (L) STANDARDS

ADVANCED LIFE SCIENCES: FOODS is a standards-based, interdisciplinary science course that integrates biology, chemistry, and microbiology in the context of foods and the food industry. Students enrolled in this course formulate, design, and carry out food-base laboratory and field investigations as an essential course component. Students understand how biology, chemistry, and physics principles apply to the composition of foods, the nutrition of foods, food and food product development, food processing, food safety and sanitation, food packaging, and food storage. Students completing this course will be able to apply the principles of scientific inquiry to solve problems related to biology, physics, and chemistry in the context of highly advanced industry applications of foods.

Standard 1

Chemistry of Food

Students know a significant amount of chemical background information that relates directly to various foods and their preparation. Chemical structure, composition, and reactions all figure into the chemistry of food and ultimately for human nutrition. Also, governmental regulations have an effect on the ingredients and additives that can be used within certain food preparations.

Background Chemistry

FS.1.1 Recognize the most common elements important in biological systems and their placement in the Periodic Table of Elements including C, H, O, N, P, and S.

FS.1.2 Describe the formation and structural significance of single and double bonds between carbon atoms.

FS.1.3 Compare and contrast covalent and noncovalent bonds, such as, hydrogen and ionic.

FS.1.4 Diagram the benzene ring structure.

FS.1.5 Describe composition and arrangement of functional groups found in biological systems including aldehydes, ketones, alcohols, amines, amides, esters, and sulfhydryl.

FS.1.6 Describe the differences in terms of chemical structure and reactivity between hyrophilic vs. hydrophobic molecules.

FS.1.7 Define hydrolysis including the role of acid, heat, and enzymes in hydrolysis reactions.

FS.1.8 Discuss the chemical composition and structure of protein molecules including primary, secondary, tertiary, and quaternary structures.

FS.1.9 Describe the reaction resulting in the formation of a peptide bond

FS.1.10 Discuss the relationship between amino acid sequences and protein identity.

FS.1.11 Understand the oxidation process and describe the chemical reactivity of antioxidants.

FS.1.12 Understand the hydrolysis of triglycerides by lipases

FS.1.13 Explain the physiological food fuel values for macronutrients and food calories. Furthermore, explain and understand Lavoisier's theory of metabolism

FS.1.14 Discuss the biochemical and physiological functions of proteins, carbohydrates, lipids, vitamins and minerals. Explain the structure and function of phytochemicals – non-nutrients; chemical and biological importance.

FS.1.15 Describe the various types of irradiation used in food preparation/processing including the amount of energy produced by each type of radiation and the dosage effects.

FS.1.16 Explain thermodynamics and kinetics (e.g., reaction rates for affecting quality and destroying nutrients). Compare and contrast the chemical reactions initiated by the effect of heat, oxygen, acid, and light during processing and storage of foods. In addition, explain how refrigeration or freezing affects rate of chemical reactions.

FS.1.17 Discuss flavor and aroma compounds in terms of the organic functional groups including aldehydes, esters, and ketones. Furthermore, explain the effect of heat and acid on their stability.

Applied and Practical Food Chemistry

FS.1.18 Define oxidation and reduction, and explain how a redox reaction works. Explain the importance of oxidation and reduction in food science.

FS.1.19 Using food labels and tables of food composition, identify foods that are high and low in protein, lipids, and carbohydrates.

FS.1.20 Explain the denaturation process of proteins with heating or physical treatment through examples, such as, frying an egg and whipping egg whites.

FS.1.21 Describe the process and products of the hydrolysis of protein molecules by enzymes using examples including rennet to make cheese and papain in papaya.

FS.1.22 Explain the color change of myoglobin in meats due to oxygen and metal ions.

FS.1.23 Distinguish between the chemical structure of fatty acids, mono-, di-, and triglycerides and phospholipids, and relate the chemical and physical properties of fats and oils to their chemical structures.

FS.1.24 Compare and contrast saturated, monounsaturated and polyunsaturated fatty acids

FS.1.25 Describe the hydrogenation process as it relates to changes in chemical and physical properties; cis vs. trans fatty acids.

FS.1.26 Compare and contrast the chemical structures of monosaccharides, disaccharides, and polysaccharides including glucose, fructose, sucrose, lactose, starch, amylose, amylopectin, pectin, and glycogen as these relate to foods.

FS.1.27 Explain the chemical reactivity of hydroxyl and aldehyde groups in reducing sugars.

FS.1.28 Describe the process and products of the hydrolysis of carbohydrates with enzymes (e.g., invertase, amylase), acid, and heat – e.g. sucrose, starch, glycogen.

FS.1.29 Explain the starch properties of granules and gelatinization.

FS.1.30 Explain the chemical properties of pectin as they relate to viscosity of jams and jellies.

FS.1.31 Demonstrate an understanding of the components of dietary fiber, their solubility characteristics, and how this relates to quantitating dietary fiber.

FS.1.32 Identify minerals important to biological systems, specifically foods and human nutrition.

FS.1.33 Describe the chemical structures of vitamin C, B vitamins, and fat-soluble vitamins A, D, E, and K. Describe the chemical significance of fat-soluble vs. water-soluble vitamins in biological systems, and explain the effect of heat and oxygen on their stability

FS.1.34 Describe the chemical structures of organic acids and their roles in foods including citric acid in oranges and lemons, tartaric acid in grapes, and malic acid in apples. In addition, discuss D- vs. L- form of malic acid, and what is naturally present.

FS.1.35 Define and give examples of natural toxicants including oxalic acid in spinach and rhubarb, enzyme inhibitors and lectins in legumes, and alkaloid solanine in potatoes.

FS.1.36 Compare and contrast various browning reactions including enzymatic and non-enzymatic reactions. Give examples of desirable and undesirable effects.

Additives and Regulations

FS.1.37 Discuss the processing additives and final product additives including their chemical, physical, microbial effects on food components. Explain examples, such as, sodium bicarbonate forming carbon dioxide for foaming and leavening, pH control agents such as citric and carbonic acid, antioxidants such as BHA and BHT, chelating agents such as citric acid, and emulsifiers such as lecithin. Describe the chemical similarities and differences between sugars and artificial sweeteners in foods and food processing. Also, demonstrate knowledge of how food additives are regulated compared to dietary supplements (Food Additives Amendment to FD&C Act vs. DSHEA Act).

Standard 2

Health, Safety, and Microbiology of Food

Students are acutely aware of safe food handling, hygiene, spoilage, and quality. This encompasses issues from temperature controls, species and structure of microbes, shelf-life, food-poisoning, and the socio-economic impact of the food quality.

Microbes and Health

FS.2.1 Explain the taxonomy, naming, and classification systems of microorganisms.

FS.2.2 Describe the structure of bacteria, viruses, yeast and molds.

FS.2.3 Compare and contrast the nutrients and physical conditions required for microbial growth. Also, describe the microbiological sampling and culturing methods used in food science.

FS.2.4 Explain how temperature, water activity, pH, oxygen and redox potential, interactions among different microbes, and interactions between different antimicrobials all affect the growth of microorganisms in food systems.

FS.2.5 Describe agents that lead to inactivation of microorganisms including heat and heat processing, cleaning and sanitizing agents, food preservatives, irradiation and ultraviolet (UV) light, and high pressure. Discuss their mode of action. Describe the electromagnetic spectrum using frequency and wavelength, and identify types of electromagnetic radiation appropriate for use in irradiation of food. In addition, express an understanding of the "hurdle effect" used to ensure microbial safety.

FS.2.6 Identify the various food spoilage methods including microbial spoilage, chemical spoilage and their effect on food product shelf-life. Identify organisms commonly involved in food spoilage. Provide examples of food spoilage, and explain how to minimize or control food spoilage.

FS.2.7 Identify the sources of the microorganisms involved in food-borne illnesses. Describe the types and causes of various food-borne illnesses and outbreaks. Identify diseases caused by microorganisms and distinguish between food poisonings and food-borne

infections. Explain how to control food-borne disease. Also, explain the economic and social impacts of food-borne illness.

FS.2.8 Identify the types of food fermentation, and describe the chemical processes involved in food fermentation. List four chemical products of fermentation that flavor and/or preserve foods including acetic acid, lactic acid, and propionic acid. In addition, describe the benefits of fermented foods.

Safety

FS.2.9 Define food safety, food quality, and emerging issues and problems associated with food microbiology.